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There were three foci of research during the granting period. First, a project was concerned with stimulus-driven shifts of attention. This project was concerned with setting boundary conditions on when salient stimuli in the visual periphery could elicit shifts of attention without shifts of fixation. Second, research was conducted to study the integration of visual information across successive fixations. This research examined a simple model of saccadic integration, a model that was found not to be supported by experimental evidence. Third, experimetation was conducted concerned with the mechanisms involved in programming saccadic eye movements. In addition to these projects, several other issues were raised during the research period that resulted in experimentation and subsequent publication of results. These issues had to do with the cevelopment of automaticity in mental processing, the perception of geometric illustions, analysis of reaction time data, and attentional issues more generally.

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FINAL TECHNICAL REPORT

PERCEPTION OF COMPLEX DISPLAYS

AFOSR-82-0297

Principal Investigator John Jonides

8 December, 1988

Summary

There were three foci of research during the granting period. First, a project was concerned with stimulus-driven shifts of attention. This project was concerned with setting boundary conditions on when salient stimuli in the visual periphery could elicit shifts of attention without shifts of fixation. Second, research was conducted to study the integration of visual information across successive fixations. This research examined a simple model of saccadic integration, a model that was found not to be supported by experimental evidence. Third, experimentation was conducted concerned with the mechanisms involved in programming saccadic eye movements. In addition to these projects, several other issues were raised during the research period that resulted in experimentation and subsequent publication of results. These issues had to do with the development of automaticity in mental processing, the perception of geometric illustions, analysis of reaction time data, and attentional issues more generally.

Research Objectives

a. Stimulus-Driven Shifts of Attention

The objective of this portion of the project was to test whether salient stimulation in the visual periphery elicits a shift of attention to the stimulated location. This was assessed in the context of a visual search task in which reaction time measures could be modeled to show that stimulated locations were examined first before any other locations in the display. The specific goals of the research were to answer four questions? Will a shift of attention be elicited by a salient peripheral stimulus? Will *any* salient stimulation cause such a reflexive shift? How can shifts of

attention to peripheral stimulation best be modeled? Are shifts of attention that are voluntary related to shifts that happen reflexively?

b. Integration of Information across Fixations

This portion of the project was concerned with testing whether information is integrated across fixations by a mechanism that stores the contents of each fixation with great fidelity and integrates the contents of successive fixations by spatially reconciling and superimposing the contents of each. This model was to be tested using a paradigm in which subjects were required to take in information during two fixations, integrate this information, and arrive at a judgment about the combined image.

c. Programming Saccadic Eye Movements

A number of experiments were to be conducted with a paradigm involving partial advance information to study how saccadic eye movements are programmed. This research was to result in the development of a model in which programming of distance and direction of an upcoming saccade were seen as separate operations. The experiments were designed to measure the latencies of saccades and to draw inferences about advanced programming of these saccades that could be applied to the development of the proposed model.

Status of Research

a. Stimulus-Driven Shifts of Attention

The first line of research on this problem established that suddenly onset stimuli exert control over the allocation of attention. The results of this research show support for a mathematical model in which attention is assumed to be captured by an abruptly onset stimulus before it can be allocated to other locations in the visual field. According to this model, abrupt onsets exert irrevocable control over attention.

Continuing work on this phenomenon concentrated on two issues:

1. The uniqueness of abrupt onset

Experiments were conducted that directly compared the effectivenesss of abrupt onset versus brightness and hue differences in capturing attention. This research established that hue and brightness differences were not sufficient to cause an allocation of attention, although abruptness was.

This indicated that abruptness has a priveleged position as a stimulus characteristic.

2. Voluntary versus involuntary shifts of attention

The goal of this research was to test whether shifts of attention due to peripheral stimulus presentation were completely involuntary. Tests of this hypothesis involved pitting stimulus-driven shifts of attention against internally driven attention shifts. The research established that stimulus-driven shifts are not immutable. Their effect can be dampened by voluntary allocation of attention.

b. Integration of Information Across Saccades

An oft-cited model of integration is that information is carried across saccades by a memory that preserves literal copies of each fixation, with spatial coordinates so that spatial reconciliation and superimposition are possible. This model was tested in an extensive series of experiments in which subjects had to view a partial array of dots in one fixation and integrate it with another array in another fixation to make a judgment about a missing dot. The early stages of this research suggested support of the model, but this was a result of an artifact in the equipment used. Later research, after correction of the artifact, showed no evidence in support of the model. Further paradigms were developed to test the model and to develop other models, but these proved largely ineffective for the task.

c. Programming Saccadic Eye Movements

There has been a good deal of research concerned with developing a model of saccadic preparation. The present experimentation specified a particular model and developed a paradigm to test it. The paradigm involved providing subjects with advance information about saccades that they were to execute, and measuring the latencies and accuracies of their execution. Results confirmed that distance and direction of saccades are two parameters that are separately programmed in advance of saccadic execution. This led support to the model under consideration.

Manuscripts

a. Stimulus-Driven Shifts of Attention

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Jonides, J., and Yantis, S. Uniqueness of abrupt onset in capturing attention. *Perception and Psychophysics*, 1988, 43, 346-354.

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b. Integration of Information Across Saccades

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c. Programming Saccadic Eye Movements

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Jonides, J. Reports of the icon's demise are premature. *Brain and Behavioral Sciences*, 1983, 6, 24-25.

Siegel-Jacobs, K., and Jonides, J. Location and Identity information in short-term visual memory. Manuscript in preparation.